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ABSTRACT

Results of research on secondary schools with unusual success in attracting and holding young women in their mathematics and physical science curricula are presented. The selected schools were chosen based on the number and percentages of females taking the Advanced Placement Program (APP) Examinations. Using a combination of individual and group interviews, the investigation focuses on factors and influences guiding female students towards Advanced Placement (AP) courses. Suggestions for encouraging and preparing greater numbers of young women to pursue scientific or technological studies and careers are identified. (MP)

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HELPING ABLE YOUNG WOMEN TAKE MATH AND SCIENCE SERIOUSLY IN SCHOOL

SE 033 693

PATRICIA LUND CASSERLY

Helping able young women take math and science seriously in school

Abstract

The usual needs and problems of counseling talented high school students with respect to their studies are especially complex and acute when the students are girls and their studies are—or should be—mathematics and the physical sciences. If young women with powers and interests in these fields are to have practical opportunities for careers related to their gifts, new strategies and tactics will have to be used by counselors as well as teachers.

One recent study (of strong high school math and science programs that attract and hold high proportions of girls) and one still underway (of such math programs in both junior and senior high school) have led to the following conclusions:

1. Homogeneous grouping, as in Advanced Placement, gives such students appropriate pace in their sequential studies and a sense of company along the way. It also provides stimulus and preparation toward professional careers in related fields. Such courses should be fostered.

2. Advanced Placement teachers in mathematics, chemistry, and physics are excellent agents for recruiting girls to those fields for study and later careers. This departmental role should be recognized and served.

3. Much effective college and career counseling takes place in Advanced Placement classes. Schools should assist Advanced Placement teachers in this role.

4. Few counselors encourage girls to pursue studies and careers in mathematics and physical science. They must be made aware of this weakness and of ways to overcome it.

5. Older girls can be especially helpful in encouraging female students to elect and maintain studies in mathematics and science. This is particularly true in early junior high school and late senior high school. Advanced Placement girls can serve as useful models to seventh and eighth graders, while recent graduates, now at college, can well be invited back to talk with both the junior and senior high school groups.

Many years ago I read a book about persons of great talent and genius who had enriched and changed European society in the 18th and 19th centuries. The title and author have long since escaped me, if they ever registered in my memory bank at all, as have the names of many of his subjects, although I remember a few—Beethoven, Samuel Johnson, Edouard Manet. What I do remember is that the author addressed a controversy of which in my young life I had been unaware. Briefly stated, the controversy centered around whether giftedness of all sorts flourished in spite of the social context in which the gifted one lived, or whether the flowering of an individual's talent was dependent in some ways on a peculiarly nourishing social and intellectual climate. The author made a convincing case for the latter position. And I remember at the time being extremely grateful not only that Beethoven, Johnson, and Manet had lived, but that Beethoven had had sympathetic patrons; Johnson had had a circle of supportive friends that included Oliver Goldsmith, Edmund Burke, and James Boswell; and that Manet had had a strong following of fellow painters and the companionship of Emile Zola. For it was clear that had not these friends and mentors been nearby to provide support and opportunity of various kinds, we would all be the poorer. For there were times in the lives of all these persons, whom we now identify as "gifted," when they were discouraged, out of money, unaware of existing opportunities, or traveling in intellectual or artistic realms so distant from those of the prevailing culture that their unique contributions to human society might never have been realized, let alone recognized and preserved for us, had it not been for the presence of what we now speak of as "support groups." As a wise gardener friend, looking over a remarkably luxuriant stand of peas remarked recently, "It's not superior seed that's uncommon, but the combination of superior seed, superior soil, and ideal weather that's so uncommon."

What brought all these threads to mind was another conversation I had recently with a very nurturing woman who is a teacher of the gifted and talented students as well as of those on the other end of the ability scale. She remarked,

near the end of an exhausting school year, "Yes, it is fun teaching the gifted, but yet sometimes strangely unfulfilling. After all," she continued, "they're so bright and have so much that there's very little I can give them." Implicit in her statement is something I have found to be a misperception, namely that the gifted don't need us. In comparison to other students—particularly those at the other end of the spectrum—they seem to have it all: brains, beauty or handsomeness, and sensitivity. In the sight of all these gifts, we have to ask ourselves what can we possibly do for these fortunate ones? Perhaps the only thing is to "get out of their way." In contrast, the needs of those on the other end of the continuum are all too apparent, and the needs of those in the middle are often familiar and comprehensible and therefore more easily recognized and met.

But the considerable time I have spent in public schools talking to students (and their teachers and counselors) during the past few years, coupled with biographies and autobiographical statements of achievers in various fields, convince me that talented and gifted students (however locally defined) need us very much indeed, perhaps more than students with lesser abilities.

Why? Because they are just as far from the norm as less fortunate "slow learners" or "educables," and there is usually a price paid for being different. For the gifted, it may be only a vague uneasiness. Or it may be acute discomfort accompanied by guilt. For in a society that is a meritocracy, but in which all are nevertheless supposedly equal, there seems to be something almost undemocratic, and therefore bad, about having more than one's share of talents and abilities to meet life with, particularly when they are "given" and not "earned" by hard work.

The schools reflect and perpetuate two seemingly conflicting messages of our society: the first arises from our belief in "equality," and like many religious creeds which become automatic and therefore thoughtless with thousands of repetitions, we forget the qualifiers of the original concept. This message gains strength from another source, the need of any society for normative behavior on which social order—any social order—rests. After all, what are schools for but to socialize ever new hordes of young barbarians and make them willing and able to serve in the roles society needs to have filled?

The second message arises from our Judeo-Christian heritage (the Old Testament story of the servant with ten talents) and capitalist ideology; it encourages the full development and uses of resources and assets.

Somehow the school, while passing on the cultural heritage and encouraging normative behavior, must also provide students the opportunity to develop their abilities to the fullest. Moreover, an evolving society needs to grow its own critics and innovators. It is far easier to know what to aim for with children with an IQ (however measured or defined) of 60 or 80 than it is with children who test 130-140 or above, for in the first case we know much more about what we're aiming at. We're aiming to make them as "normal" as possible. We hope we can teach them to dress themselves appropriately, keep themselves clean, get to places on time, develop functional literacy, and learn to do some kind of work that is useful to society and thus reap the benefits of satisfaction and happiness that being "contributing" and therefore "valuable" members of it provides.

But what are we aiming for with a high IQ child, particularly if s(he) is a "divergent" thinker? (This phrase is used for a broad spectrum of behaviors. It describes students who come up with truly new solutions to old mathematics problems, as well as describing plain "trouble makers." I shall come back to the latter further on.) We know practically nothing at all. We can't recognize inventions before they are invented, hear music before it is composed, have our insights deepened and sharpened by literature before it is written, or be enriched by paintings before they are painted.

All adults in a school system are involved in counseling students and therefore are and should consider themselves as members of student support groups. All give advice and recommend or instruct in future courses of action or behavior. The office secretary counsels when she advises, "You'd better see the principal about that." So does the auto mechanics teacher who tells one of his charges, "There's a job down at Mac's after school, if you hurry." And so does the teacher who points out the relevance of the calculus to a would-be epidemiologist.

But what about the counseling done by those specifically designated to fulfill that role within the school system? Based on my research of the past few years, it seems that those whose job it is, do least. I can hear the outraged or resigned objections to this statement and understand. Don't I understand that counselors have case loads of three, four, or five hundred students; have to spend "outrageous" amounts of time filling out forms; spend time at the police court, conferring with family service, and so on? Yes, I do. And I sincerely wish I could come up with a plan that would get them out of the psychotherapy business, reduce case loads, and relieve them of the paperwork that should and could be handled by an efficient clerk. Instead, I am going to suggest several additional factors that contribute to the slighting of the counseling of the gifted—particularly gifted women.

Gifted young women seem to fall into two categories: those who are "no trouble at all" or those who are "lots of trouble." Girls in the first group have excellent academic records, are leaders in extracurricular activities, and get along as well with adults as they do with their peers. They are as good at social adaption as they are at everything else. Girls in the second group may also have excellent academic records, or there may be a few glaring exceptions in their usually high performances. They may or may not participate or excel in extracurricular activities. One thing is certain: counselors and teachers find them difficult and unlikeable. Solano (1976)[1] confirmed my observations when she reported that, even after a course in dealing with the gifted, the counselor and teacher participants felt more comfortable with gifted boys but even less comfortable with gifted girls than they had at the beginning. Old stereotypes die hard, and behavior continues to be perceived differently depending on the sex of the doer. Too often in the school the behavior that is evidence of "critical thought and a questioning mind" in a young man becomes evidence of "insolence" and an "argumentative nature" in a young woman. Similarly, "high animal spirits" become "disruptive behavior," and "independence" becomes "anti-social." It's hard to feel helpful toward people who threaten us in some way, particularly when they're brighter than we are. And it is *our* attitudes and behavior that must change if we wish to preserve intellectual resources for the future. As the late Dr. Anna Starr, co-founder of the Rutgers Psychological Clinic, frequently admonished her students about the retarded, "You can take a lot out of a young person—wit, intelligence, spirit—but if its not there to begin with, you can't put it in." I'd like to concentrate on the first part of her remark in speaking of gifted women. We take a lot out of them—not only by forcing them to conform to stereotypically docile "feminine" behavior, but by letting them slide through school with minimal effort. I've met many young women who've done just that until twelfth grade or college when they were suddenly confronted with something that took effort. The confrontation was sometimes disastrous. Lack of intellectual challenges until 17 or 18 is no preparation for the "90 percent perspiration" that goes with the "10 percent inspiration" that is reported by the achieving gifted. And it seems harder for young women to change their behavior than for young men because of internalized societal constraints.

Laziness is a hard habit to break and discipline a difficult habit to acquire. I've found that gifted young women are particularly adept (often to their disadvantage) at living up to the expectations of others *and no more*. Well adjusted, pleasant young ladies don't make waves or they're suddenly seen as "aggressive" or worse. Young men who suddenly demand challenging work are seen as finally settling down and getting serious about life and their future careers. I encourage counselors to delve a bit as they sign off on the next year's course selections of their gifted young women. Are these students meeting any real challenges in their present work, or is minimal effort earning them "A's"? If so, let's see if we can build some truly stretching experiences into next year's program. For if we are serious about developing resources, we should be at least as serious about bringing work up to the level of these students as we are about bringing other students up to grade level.

The gifted often start out an activity at a level of competence only achieved by their less fortunate but adequately bright classmates through hard work and practice. Always being at the top of the class without effort leads both to undervaluing those products of others that are true achievement, that is, products of focused effort, and to disrespect for the school system which rewards equally aptitude and effort.

If we have made sure that our gifted students have been led to all the challenges the school can provide through the years, there is still a critical task before us: to help them through the transition to college.

If students have been appropriately challenged all along the line, "getting out of their way" may indeed be enough for some with (a) adequate financial resources, and (b) resource persons outside the school who are aware of the full array of educational opportunities beyond secondary school and who have the "know how" and willingness to help the young woman to pursue these opportunities. But if one of these extra-school elements is missing, counseling is critical.

Young women from working- and lower-middle-class homes and their parents need particular encouragement to apply to prestigious and highly selective colleges and universities. Their families may not think a daughter's education is as important as a son's. And they are less likely to be aware that, on the whole, prestige and resources for financial aid go together. Yet, throughout the years, I've seen young women go off to Smith or Harvard who couldn't afford the state university, and I have been asked by admissions officers from other first-rate colleges to find girls who are mathematically or scientifically gifted for available scholarships.

These thoughts have grown out of my observations in two studies. One, *An assessment of factors affecting female participation in Advanced Placement programs in*

1. Solano, C. H. *Teacher and pupil stereotypes of gifted boys and girls.* Paper presented at the 1976 meeting of the American Psychological Association, Washington, D.C., September 1976.

Mathematics, Chemistry, and Physics, was made possible by the National Science Foundation and the College Board. The other, *Factors related to young womens' persistence and achievement in Mathematics, with special focus on the sequence heading to end through Advanced Placement Calculus*, is supported by the National Institute of Education and is currently underway. A condensed version of the first report follows. Although only parts of it deal with "school counselors," I hope all of it will be helpful to anyone concerned with *counseling*. The payoff in working with the gifted—unlike many of the rewards of working with slower students—is apt to be far removed in time, but is well worth the effort, to us and to society.

Background

Traditionally, the physical sciences and mathematics have been male provinces; relatively few women have crossed the borders to seek eminence in these domains. In 1971, for example, women were awarded 0.8 percent of the baccalaureate degrees in engineering, 18.2 percent of those in chemistry, 7.2 percent of those in physics, and 37.5 percent of those in mathematical subjects.[2]
At the graduate level in 1973, only 9.7 percent of the Ph.D's in chemistry, 3.5 percent of the degrees in physics and astronomy, and 9.7 percent of the degrees in mathematics were awarded to women.[3] These statistics reflect a progressive attrition and are not surprising to anyone familiar with the general proportion of females to males in high school classes in the physical sciences and in mathematics courses more advanced than the minimal requirements for graduation or for admission to selective colleges.

Achievement in these fields is by nature more sequential than in most other fields in the high school and college curriculum. Even at the introductory college level, many physics courses presuppose calculus, most college introductory chemistry courses presuppose three years of high school mathematics, and physical chemistry presupposes calculus. It would be practically impossible to major in mathematics if one came to college with less than four years of high school preparation in the subject; five would be better, if they can be squeezed into four. In college, one cannot suddenly discover and "jump into" astronomy, civil engineering, or bio-chemistry—as one might into Middle English or Russian history—without prescribed prerequisites.

Clearly, in the physical sciences, mathematics, and related fields the national output at the bachelor level and beyond is limited by the pool of students studying in these areas at the secondary school level. If we are concerned with national sources of preprofessional talent and accept the research that shows girls to be as bright and able as boys and to be recognized as such by their teachers, then we would hope to find girls represented in their natural proportions to boys in the initial pool.[4, 5] Unfortunately, relatively few girls are enrolled in high school science and mathematics courses. Consequently, it is highly important to identify ways to encourage girls to develop their intellectual powers and particularly to enroll in high school physical science and mathematical classes. What factors tend to encourage female participation and what factors tend to discourage it?

This study attempted to isolate some of these factors by examining a number of secondary schools which have had unusual success in attracting and holding young women in their mathematics and physical science curricula, as evidenced by the proportion of girls to boys who take the College Board's Advanced Placement Examinations in these areas.[6] It is our hope that the findings will be useful to those in schools elsewhere who wish to encourage and prepare greater numbers of young women to pursue scientific or technological studies at college and beyond.

A brief explanation of the Advanced Placement Program may be in order. This Program, sponsored by the College Board, is designed to stimulate advanced studies in secondary school for able, interested students and to assure their appropriate reception, with credit and placement, at college. It operates through working committees of school and college teachers in 12 fields commonly shared between the latter years of secondary school and the early years of college. The committees state each year their understanding of the curricular goals of a generality of introductory college

2. Statistical Abstracts of the U.S. 1974 National Data Book and Guide to Sources, U.S. Department of Commerce, p. 139.
3. Summary Report 1973 Doctorate Degrees from United States Universities, National Academy of Sciences, May 1974, Washington, D. C., p. 116.
4. Pike, L. W. Personal communication, June 18, 1975.
5. Macoby, E. L., and Jacklin, C. N. The Psychology of Sex Differences, Stanford, California, Stanford University Press, 1974.
6. The Advanced Placement Program was established to encourage and enable schools and colleges to recognize the special talents of individual students by offering them the opportunity to move ahead at their own pace. At the same time, while recognizing individual differences among students and offering more demanding and challenging work than is usually found at the high school level, the Program has acted as a stimulus in pioneering curricular reform.

The Program provides schools with AP course descriptions for 24 courses in 12 fields: art (three courses), biology, chemistry, English (two courses), French (two courses), German (two courses), history (two courses), Latin (two courses), mathematics (two courses), music (two courses), physics (three courses), and Spanish (two courses). It also offers the assistance of professional consultants to help schools establish Advanced Placement opportunities; develops, administers, and grades examinations based on these studies; and reports the examination grades to the student's college. Participating colleges and universities then grant credit and appropriate placement to candidates presenting qualifying grades.

courses in the field, and set examinations of up to three hours length to certify their attainment in self-nominating participating schools. Participating colleges, in turn, normally grant qualified candidates placement, with appropriate credit, into advanced college courses. Repeated research studies, performed both at Educational Testing Service and at participating colleges, have shown that qualified candidates (1) out-perform, in advanced courses, otherwise similar students who, without Advanced Placement in schools, completed their first-year college work at colleges, and (2) have a higher tendency to persist in their fields of Advanced Placement study than do college freshmen in similar introductory courses.[7,8] For the student, the AP Program can be said to "work," and to the researcher, its participating schools offer a visible, defined set of demonstrably strong programs in chosen fields.

The sample

The sample was drawn in three stages during August 1974. Using data provided annually and routinely during the summer after the (annual) May administration of the AP Examinations, I identified those schools which presented significantly higher proportions of girls in the mathematics (calculus), chemistry, and physics AP Examinations than was true of the Program as a whole in these fields. On a national basis in 1974, only 17.2 percent of the AP candidates in Chemistry were girls. Only 27.9 percent of those taking Calculus AB were girls, as were 21 percent of those taking the Calculus BC examinations. Only 12.9 percent of those taking the Physics B examinations were girls, as were 6.8 percent of those taking Physics C. In choosing the initial sample, I looked for schools that had at least twice the national ratio of girls to boys in at least one of these fields. Then I narrowed the sample to those schools that had the desired proportion of girls in two of the three fields under study and/or at least five girls in one of the two other fields. Finally, I tried for as much socioeconomic variety and regional representation as proved possible within the constraints already imposed. Twelve high schools were initially asked to participate in the study. Additional funding by the College Board made it possible for me to later add an additional high school and AP teachers from seven other high schools, as well as guidance counselors from several junior high schools.

About a third of the schools are in the midst of large urban centers drawing heavily from working-class (blue collar) neighborhoods. Another third are also urban but draw a greater number of middle-class students. The remaining third are suburban schools serving a high proportion of students from professional and upper-middle-class (management) families.

Procedure

Visits to the schools were carried out from November through April 1974-75. My original plan had been to sit in on the appropriate classes in order to get a sense of teaching styles and of patterns of interaction and participation among students, and to conduct individual interviews, lasting from a class period to over an hour, with the girls, teachers, and guidance counselors around the classes. But in the fourth school I visited, the girls' schedules were so tight that the only time I could talk with them was during the AP class (which was fortunately two periods); so we held a group discussion after each girl had filled out a short biographical questionnaire hastily adapted from the outline designed for individual interviews. This shift from individual interviews to structured group discussions proved to enhance rather than diminish the quality and specificity of the girls' responses in many areas. The girls jogged each other's memories and sharpened one another's suggestions for the task at hand. The discussion format also gave me a far richer picture of the girls' formal educational experiences and of the uniqueness of their particular school system than did individual interviews. Not least important was the fact that overblown generalizations and misinterpretations of classmates' perceptions and motivations and problems were corrected on the spot.

Because of the success of this initial group discussion, which had taken place out of necessity, I scheduled others at the remaining schools to be visited for the study; thus, at these last nine schools, I conducted both individual and group interviews. This flexibility provided an additional advantage: in this way I was able to talk with all except three of the girls in the target population who were in school during the time of my visits, rather than only five from each class. A total of 161 of the girls currently enrolled in AP classes participated in the study, 70 of whom were interviewed individually. The rest participated in group discussions only or were seen twice, in individual and in group settings.

In all but one school, interviews with AP teachers were conducted individually, although on several occasions I also met for a time with all members of a department. When time and the occasion presented itself, I also interviewed teachers responsible for the pre-AP courses. And again, when time and the opportunity permitted, I

7. Casserly, P. L. *To see ourselves as others see us, an evaluation of the advanced placement program by students from 252 secondary schools at 20 colleges.* College Entrance Examination Board Research and Development Reports, RDR 67-8, No. 5.

8. Fry, D. E. Comparison of the college performance in calculus-level mathematics courses between regular-progress students and advanced placement students. (Doctoral dissertation, Temple University.) Ann Arbor, Michigan: University Microfilms, 1973. No. 73-23, 333.

talked with other teachers outside the mathematics and science fields that either students, their AP teachers, or members of the administration had identified as enhancing the aspirations of young women in the schools. All but two of these teachers were female. One of these women headed the drama department; several were in social studies and history; and one taught physical education. The two males were a forty-ish guidance and career counselor, and the chairman of an English department.

I also interviewed by telephone 43 former AP students who were recent graduates of nine of the high schools in the study. In some cases the schools provided rosters with home or college addresses of 1974 graduates and gave me free rein to select the girls with whom I wanted to talk. At other schools specific graduates were suggested because their college careers and aspirations were well-known to a particular teacher or someone in the administration. They were, or were in the process of becoming, the school's "success stories." Because of the variety of methods used for choosing this graduate group of participants, no claim can be made that they are in any way a representative sample of their former AP classmates, although their perceptions strengthened many of the suggestions made by their younger sisters still in secondary school.

Discussion

Countless factors lie behind the decisions, activities, and views of young women anticipating careers in mathematics and the physical sciences. Some of these influences are so general and banal as to be outside the purpose of this study. Others, on the other hand, are so unique and accidental as to defy generalization for other reasons. The attitudes and actions, however, of at least four groups of people—parents, teachers, counselors, and students—do seem to play a regular, visible, and important role in such young people here with special reference to what counselors can do in this domain.

The discussion will revolve around a number of recurrent themes that became evident in my conversations at all the schools, rather than around statistics. I will focus attention on those experiences—mostly within the schools—that students regard either as having enhanced their interest in science and mathematics or, although well-intended, as having had little or even negative effect. (For, whatever their purpose, the "messages" of counselors and teachers are often "received" quite differently than they are "sent".) Throughout this discussion—as throughout the whole report—my aim will be to provide practical and effective observations and suggestions for people—especially counselors—committed to encouraging young women to develop their intellectual powers and interests, wherever these might lead.

Paths to Advanced Placement Courses

The girls to whom I talked had enrolled in advanced courses in the fields of this study for many reasons. For a number of them the courses were the capstones in secondary school of apparently natural sequences of courses serving their early, and later well-defined, interests.

"I guess we were always accelerated, at least we had been grouped together almost since the beginning of school. At first it wasn't that we necessarily did different things, but we did more."

"We were on the fast track from the fourth grade on.... These courses are just the culmination of a natural sequence that served our well-defined interests, you might say."

"Most of us have been together forever it seems. We've grown up together, like a family."

A number of different curricular paths were traveled by the students on the way to their AP courses in high school. Most involved homogeneous grouping at least in mathematics as early as the fourth grade; but the curricular content of the courses wasn't differentiated until the seventh grade, when some of these students took pre-algebra in lieu of the usual sequence. Although formal acceleration for these girls usually didn't start until the seventh or eighth grade (when some went right into algebra from the regular mathematics sequence, skipping pre-algebra), the girls generally agreed that homogeneous grouping in the lower grades had had distinct advantages. The most important of these were psychosocial, although a number of girls also spoke of the enrichment that had kept boredom at bay. Such arrangements:

"Made us a group . . . who by junior high were pretty independent of the other high school culture. We didn't mind being smart—in fact we really liked it."

"Yeah, we still do! We're really competitive with each other and the boys—but let one of *them* try to put anyone of us down and we close ranks."

"... And help each other."

"Let's face it, we were different . . . where other girls were worrying about who was going to take them to the basketball game, we were worrying about how to get a ride to the county library (across town) or down to New Paltz for our projects."

"Junior high was the worst time for us—the absolute worst—with going to a new school and a whole different social scene. And lots of the other students thought us a bit weird—only boys had been in the pre-med club before."

Over and over again, girls remarked on the importance of girlfriends who shared "common school experiences and similar interests on similar levels" in dealing with the teasing and disap-

proval of boys, which "peaked at the ninth grade." Although boys who had come up with the girls in the accelerated group teased too, they did so "half-heartedly" or "good-naturedly." "They were used to us and we were used to them—they were really like brothers" and so they remained into the last years of high school. (When I asked whether their social groups outside school mirrored their academic group in school, the vast majority of girls in all schools said that although many of their girlfriends were in the same classes they preferred to date outside their AP classes in mathematics and science, though a number dated boys in other AP classes. I shall discuss this matter further in a later section.)

For the girls who were not tracked early, the potential placement into algebra in the eighth grade was often almost traumatic. Such girls reported that other girls in their class had rejected the option when it was presented, either on their own or because parental awareness and support were lacking. "It's an awkward age, and some girls feel like they're being singled out at a time they'd like to be anonymous." For girls already tracked, the option never arose, nor did the opportunity arise for a guidance counselor to ask, as some were reported to have done, "Why do you want to be ahead? You certainly don't need all that math for college." Such statements show ignorance of the prerequisites of upper-level high school courses as well as the demands of many college courses. They close doors prematurely.

Three of the schools in the study did give strong students who had studied algebra in the ninth grade a chance to jump ahead (or to catch up with their more advanced classmates) by combining either tenth- and eleventh- or eleventh- and twelfth-grade mathematics. I was told, however, that many more boys than girls were encouraged to choose—and actually used—this option. According to two students who spoke for many others I talked with, by ninth grade (often the last year of junior high school) "the school culture is such that mathematics suddenly seems 'harder' for girls than for boys." Sex typing is at its peak, and it takes an unusually motivated and self-confident girl to buck it and say "so what?"

At two other schools several unaccelerated girls reported that they had caught up a year or two in mathematics by going to summer school. In one school this was no longer an option, since summer school was being dropped for lack of funds. And in another school, at the foot of a highly selective university, several girls reported that they had studied mathematics "on the outside" since grade six "for fun" with a private tutor who brought his small groups of students up to college mathematics by the time they were 15 or so. This meant they could take AP mathematics and AP physics with calculus as tenth-graders if they wished, and several were doing so.

The paths leading to the AP courses in the physical sciences reflected two divergent attitudes toward the secondary school science curriculum. As it happened, they were almost equally represented in the schools under study. At one group of schools, it was thought most important to give a student interested in *any* science a good scientific background in *all* the scientific fields the school had to offer. The student had to study general science or physical science followed by regular courses in biology, chemistry and physics before she could enter an AP course in any of those fields. This meant, effectively, that AP science courses were senior courses and that most students were limited to a single AP course in the sciences because of the laboratory time required. Not only that: often the laboratory sections of the AP sciences were scheduled for the same period, so that even if students were willing to put in the time for two AP science courses, such scheduling was impossible.

In several of the schools employing this approach, some students—identified in junior high school by their mathematics and reading scores and their interests—had been allowed to substitute biology for physical science in the eighth-grade, just as most of them had substituted algebra for regular eighth-grade mathematics. This had gained them a year and had meant they could take one AP science course in each of their last two years.

In two schools where general science was a part of the ninth-grade curriculum, followed successively by biology and the two physical sciences, AP students either had to take two regular sciences in one year or, in their senior year, one AP science and one regular science in order to satisfy the science departments' requirements. In one school, every senior girl in AP chemistry was also enrolled in a regular physics class. None had wanted to study physics in earlier years, so concurrent enrollment in regular physics had been a condition for their enrollment in the AP chemistry class.

The concern for providing students with a broad science background that underlies such policies is understandable and well-intentioned. On the other hand, I was told by the girls that such policies had discouraged many other girls from continuing in the science of their interest on the AP level. There were indications that such requirements might work differentially for girls than for boys in our prevailing culture. At least some girls thought so. As one of them put it:

"A lot of guys tend to be interested in science, *per se*—in any and all fields. But a number of my (girl) friends are interested in only one at the moment. Why can't we just do that?"

"Besides, girls don't want to be known as science nuts by taking every science course around. I happen to like chemistry but I hate dissecting, and figuring out trajectories bores me."

In an almost equal number of schools the science curriculum was less rigidly structured: there were no prerequisites for AP science courses beyond "one other science course." The girls were divided into three equal groups. For the first group, this other course had been a regular course in the same field, although this pattern was sometimes discouraged. For the second group, the "other" science course was the ninth-grade physical science course. The third group was presented something more. How do students decide on AP science courses instead of regular pre-college science courses if the latter are not prerequisites for the former? According to one science coordinator:

"It's all there in the description of courses. We have a two-page course outline that spells out exactly what they'll be getting into and what level of mathematical competence is necessary. And we're careful to point out the extra time required outside of class and the trips to (other educational institutions) when they begin their research projects."

At a number of the schools students rely heavily on extended course descriptions that point out the differences in levels of difficulty among courses in the same field. The descriptions of AP courses include a statement of their possible benefits in college to those who do well on the AP Examinations. Such written statements are particularly important in attracting girls, since in only five schools did either students or teachers report that guidance counselors were of any help in identifying and encouraging well-qualified girls to enroll in the AP courses or to consider careers in mathematics or science. In the other schools, the advice of counselors about the curricular choices of eager and motivated girls seemed to them and their AP teachers as, at best, too conservative and, at worst, truly hostile.

Both curricular patterns outlined above have their specific advantages and disadvantages. The first does provide a general science background for those students who are not completely turned off by it. Regular pre-college courses in the sciences taught (often by the AP teacher) within each curricular pattern also give the teacher and students time to evaluate one another, and thus have some advantages for recruitment. On the other hand, students may not have the opportunity to take as many AP courses as they would if so many prerequisites were not imposed. The second pattern provides greater opportunity for students to pursue their interests in specific sciences when they and the AP teacher feel they are ready to do the work. Students do go on to other sciences after one AP course, but it is by choice, not coercion.

Students from both curricular patterns do equally well in their AP courses and on the AP Examinations. It interested me that when I told teachers in each system about the other, I often met disbelief.

"No one without a first course in physics could survive the AP physics course."

"They'll get lopsided enough in college—there's still a place for general education and it's here."

"This girl (a junior AP physics student) has been fascinated with [illegible] all her life and has done science-fair projects on some phase of it since seventh grade. And she's a whiz in math! Am I going to tell her she has to pith frogs?"

All in all, the more flexible curricular system which does not require a full spectrum of science courses seems more conducive to female participation in AP science courses than does the more rigid system. The latter system is seen sometimes as demanding a firmer commitment to science—all of it—than many girls are willing to make in high school, both for intellectual and social reasons.

So far we have considered the sequences in schools that lead to the AP courses in the study. For many girls the school provides the only formal exposure to science or mathematics. For others, lucky enough to live near a university museum or laboratory with a strong community outreach program such as the now defunct Lux Lab or the Lawrence Laboratory in Berkeley, California, or in an area where the Explorer Scouts of the Boy Scouts of America are active, there are numerous opportunities for both formal instruction and work experience outside school. About 30 percent of the girls in the study – but never more than half the girls in any AP class—had taken science (or math) classes outside school. These activities usually started when the girls were between the ages of ten and eleven.

The range of these courses covered a broad spectrum, as did the activities engaged in by any one girl. They ranged from mini-courses lasting several weekends, or a week or two, to six- or eight-week summer NSF projects and after-school semester endeavors. Many centered around environmental science projects, though the emphasis seemed to be on understanding ecosystems in general and did not focus on environmental problems *per se*. The most frequently mentioned courses of study were oceanography and marine biology, seashore management, and forestry. Geology was popular with girls living inland as well as with those living on the coasts, but only in California did girls report a special course in earthquakes. Ichthyology, herpetology, entomology, astronomy, space travel, and exploration were enjoyed by a number of others. These non-school courses seem

particularly important since, when the girls were asked to compare their extra-curricular science courses with those taken in school during the same period (late elementary and junior high years), the latter always suffered. Why?

"In school during those years (grades 4-7) we were learning something about science, after school we were doing science. . . . Oh, I don't mean we didn't have hands-on experiences in school. But they seemed somehow contrived and silly. At the museum, it was different, you sort of felt you were helping your leader with his science."

"We were junior partners in her quest. She was collecting data for her doctorate which involved a census of the inhabitants of tide pools, and she impressed on us how important it was to observe and count accurately. . . . She hadn't been there before either and was relying on us."

The above comments could have been made as easily by boys as by girls, describing the attraction of what were voluntary activities under the direction of practicing scientists compared to the compulsory science programs in the schools. But those cited below help explain the girls' less positive reactions to school courses:

"Well, of course, we had what you'd call laboratory sessions in school, which meant getting everything out of the storeroom and putting it back every day. And the teacher would always say, 'Now the boys will help me with the boxes while the girls tidy things up.' This was funny because the science equipment was on high shelves and the girls were as tall or taller than boys at that time (eighth grade). Why couldn't she have said 'Who wants to help?' or whatever? But here she was, a scientist supposedly! . . . And assigning tasks day after day that reflected sexual stereotypes rather than an objective evaluation of her students' abilities. Her denial of our obvious differences made us more self-conscious, not less."

"So this teacher came down from the high school to give a demonstration in physics and said, 'Now this is going to make a pretty big noise, so any of you girls who don't like loud noises better cover your ears.'"

"He said, 'Now this is going to be dirty so we'd better have a boy do it.'"

"And he (a high school science teacher performing a demonstration to a sixth-grade class) said, 'Now this will help you boys who fix your own bicycles, so pay attention!'"

A classmate continued, "Yeah, don't girls have bicycles too? What are you expected to do? Wait till daddy or your older brother gets home?"

"But supposing you don't have an older brother or a daddy? Which reminds me, do you have any idea how demeaning it is to ask your little brother's permission to play with his Lego set?"

This comment started a heated discussion on toys, which illustrates the kind of stereotyping many girls encounter in their earliest years in their families and why they are extra-sensitive to sex-stereotyping when they reach school. The discussion continued:

"Yeah, or his tinker toys and erector set."

"I got Lego the first Christmas I asked, but there are no boys in our family."

"Yeah—lucky you! I had to wait three years for a microscope and when I finally got it, I drove my parents wild because I went around scraping peoples' teeth for months."

This group of girls—and girls in other schools—agreed that a chemistry set had been the hardest toy for most of them to lay their hands on, either legally (by direct gift) or illegally (surreptitiously "borrowed" from a brother):

"How come your parents are so scared you'll drop everything and burn yourself?"

"Yeah, maybe what they're saying is that boys are more expendable—" (group laughter).

"Yeah, if we were in such danger and so clumsy, how come they trust us in the kitchen with the cooking and the dishes?"

Girls who were only children, eldest siblings separated from younger brothers by four or more years, or first-born girls with sisters only fared much better in acquiring the desired toys than did girls in other family positions.

Advanced Placement teachers

One girl, on her way to studying engineering at Rice University, summed up many girls' experiences with science in and out of school before senior high school this way:

"In school, they (teachers) were trying so hard to relate to us and be chatty, they fell on their faces with 'Now, you girls and you boys.' They really talked down to us. But at the labs it was 'Who wants to or who will?' And whoever was closest caught it. They were teaching the subject, not trying to ingratiate themselves. They assumed our interest because we were there, which was really funny because a lot of us were sent because our parents thought we were unchallenged in school; they wanted to keep us out of our brothers' rooms or off the streets, I suppose. I mean, we didn't start off as scientific geniuses. But it wasn't long before we were hooked. Their enthusiasm was infectious."

Other girls from different schools augmented this theme of infectious enthusiasm when talking about their AP teachers and the reasons for taking the AP course:

"Well, he's known for being a stickler, but he just lives chemistry—I mean he loves it. And he gets such a kick out of teaching it, you don't mind working for him. I'd rather work than be bored with a teacher who's bored too."

"You just know he's doing exactly what he likes best. Oh, he

tries to make jokes and mostly they're awful, but he tries so hard. He purposely botches things to keep us on our toes. He *cares* what we learn."

"The difference between Mr. X and other teachers can be summed up easily. He always says to me, 'Now you'll really need this when you study _____.' He assumes everyone is as interested in chemistry as he is. Of course, he's dead wrong about some students, but that's a better way to err. My other science teachers sort of excuse the girls and say 'Well, this would be important if you were going on.' The implication was that, of course, you're not going to so why bother."

It was when adults in schools made similar remarks and were perceived by the girls to be either "putting them down" or applying sex-linked criteria for acceptable performance that girls turned to their female classmates for encouragement and support. "Peer-group solidarity is vitally important for girls interested in science in this school," I was told by an AP coordinator. "Because this is a school of working-class kids . . . they have no one at home to offer encouragement. All they have is their determination and their dreams."

He was wrong about the girls receiving no encouragement from their families. Most of the girls in this school (and an overwhelming number of girls in the study) felt their parents were supportive, at least of the girls' *general* goals. What was lacking on the working-class parents' part was an understanding of the specific steps that could be or needed to be taken in school in order for the girls to reach their objectives. Further, the girls rarely had any first-hand experience outside school with an adult of either sex who was employed as a professional in a scientific field.

Disparaging remarks about one's abilities or goals—particularly those that reflect sexism—whether intentional or not—are more easily dealt with if there is someone within or outside the school who knows both the girl and the requirements of the field and can help her put such potentially discouraging utterances in perspective. For the girls in whose lives there were such persons, it seemed unimportant whether they were males or females. What is important is that the older person could identify with the girls' frustrations of being novices in a complex field and support the girls' educational goals, however nonspecific they are in high school. AP teachers within the schools, as a group, were seen by the girls as fulfilling this need well.

Recruitment

Girls for whom the AP class was not a natural option among a number of advanced senior courses attributed their enrollment largely to the recruitment efforts of AP teachers in lower-level science classes. Often AP teachers scanned ninth- and tenth-grade science and mathematics class rosters and asked the teachers of these courses to recommend students as potential candidates who might not show up on the basis of grades alone. "Anyone with a good mind, but a bit dreamy and unconventional? Anyone with a consuming interest in some aspect of science outside the curriculum? Anyone who's bright but drives you up a wall?" asks one AP physics teacher of his colleagues. Then some of the AP teachers who actively recruit students make a presentation to whole lower-level science classes, explaining what the AP course is, what level of work is required, and what the advantages are to the student both in college (placement and credit) and in high school (a chance to get deeply involved in a subject, a chance to do independent research and the like). Others arrange to see potential AP students individually—often more than a year before they will be ready for an AP course—to advise them on their curricular choices. A number of girls who were recruited this way reported it was the first time they had shared their specific interests and goals with an adult at school. AP teachers tend to take over the role of college and career counseling of their students—or step into the vacuum left by the guidance department.

One AP physics teacher who is also the science coordinator at his school uses *all* the techniques I encountered elsewhere to recruit students to his and other science and mathematics classes. Two beliefs—that science study has value for all students and that scientific talent is distributed equally among the sexes—dominate his efforts and are reflected in enrollment figures. Each year approximately 40 percent of the student body is enrolled in science courses and a third of these are in AP classes. There are three AP physics classes as well as AP classes in chemistry and biology. And about half of these AP students are girls. "Enrollment in science classes should be representative of the total school population and, if it's not, I ask myself why . . . and double my efforts." The attitudes and atmosphere he and his department have created are most effective in developing scientific talent regardless of sex and on whatever level it exists.

Indeed, it is hard to escape science at this school. Science trophies are purposely larger than athletic trophies and are displayed just as prominently in the main lobby. Large plaques honoring student teachers and laboratory assistants through the years hang on the walls outside the appropriate centers. Girls have shared these honors about equally with boys since this practice was initiated.

At this school, *every* year *every* student in *every* science class is counseled about science courses for the coming year, and reminded of the advanced courses available.

"We *assume* all students will continue in science. The only options we present are within the department . . ." he chuckled. (The options include an array of courses in astronomy, geology and earth sciences, computer science, electronics, and the like, not covered by the AP Program.) However, the more able students are strongly encouraged toward AP courses. "I'm against wasting time almost as much as wasting talent," he continues. "Students should get the basics (freshman college courses) out of the way in high school if they can, so they'll be able to move on when they get to college. Professional degrees take a long time in science, and yet it's a young person's field."

Once a student is enrolled in AP physics, even less of her or his future is left to chance or rather to lack of information about opportunities within the field. An extensive library within the classroom includes books on careers in specific fields as well as science classics, biographies of scientists, and science fiction. A certain number of book reports are required during the school year. Catalogues of many colleges with strong science programs are prominently displayed nearby, and pamphlets outlining unusual programs and scholarship programs are distributed to *each* member of the class. On the day I visited, two such pamphlets had arrived—one about special programs in engineering for women in the midwest. The latter was passed out to all girls with a special admonition to one of them. "Now see that your parents read this one. . . . Wes, I know you want to go to medical school, but this will help get your parents used to the fact that you may have to go outside this part of the country," he chuckled. The girl later confirmed his perception of her situation. "My father says I can study anything I want to, to be anything I want to, as long as it's done within a radius of 150 miles, and that's going to be hard to do." But when the time comes, Mr. _____ (her teacher) will come to the house and talk with him.

This teacher, like several others, called the parents of his students whenever he felt it in the student's best interest—this meant whenever the student was more than a few days behind, or more frequently when a parent needed to be persuaded to fill out the Financial Aid Form (FAF) required by colleges for a student's consideration for financial aid, or the like. Other teachers agreed that parental attitudes toward the FAF were a problem for many students, particularly girls from lower socioeconomic strata. A teacher from an urban school offered the following comments:

"The father is often reluctant to share his financial affairs with the family. . . I know most everyone in this school would qualify for financial aid, but there seems to be a cultural pattern of reluctance to apply, especially for daughters. The father is the provider and he doles out the money. Even his wife may not know exactly how much he makes—and he thinks he's got to tell her and the student. Actually, he doesn't—he just has to put it in on the form, which you know is strictly confidential. Also, sometimes pride is involved and he thinks the girl should go to _____ (a good publicly supported college nearby) that he can afford. The father of one of the girls I had last year is a case in point. She is the most exceptional student I've had in seven years, and I knew MIT would be glad to get her, but he wouldn't fill out the form. So, first I had to convince him that it *was* strictly confidential—no one would see it—not even his family, if he didn't want them to, and then that the difference in the education she'd receive was worth it. He was already feeling inadequate about not being able to pay for MIT, and I made him feel even more guilty about not completing the form. He's (an immigrant) terribly hard working and responsible. It was not like him to ask anyone for help. I convinced him he'd be doing the college and the country a favor. He just couldn't make that last big leap. It was o.k. for her to be a scientist if that's what she wanted. But he couldn't think of a girl being at the very top in her field and therefore worth the investment to the college. I finally wore him down and there she is. Call her up."

This teacher and many others in the study were fulfilling three roles that were important in accounting for the numbers of girls in their classes: that of trusted older friend, that of respected mentor in their field of interest, and that of informed and aggressive counselor interested in promising students, whatever their sex.

Girls in a few other schools were lucky to have counselors go to bat for them with their parents about the FAF and other matters relating to college choice, but in most schools counselors saw their students who were not in trouble for only a few minutes a year. They simply didn't know their students well enough to be helpful, had they wanted to be.

The role of the counselors

So far I have mentioned counselors only in passing and then in a usually negative light. This is for the simple reason, as I stated earlier, that in only five of the schools visited did either students or teachers think them a positive force in the students' lives. In two of those schools, the guidance office was credited with sharing much of the responsibility for introducing the AP Program into the school as well as for many other programs for the "gifted" student. In those five schools the counselors also seemed committed to encouraging bright students of both sexes to follow the most rigorous curricular program they could manage. However, my interviews with counselors in the other schools confirmed the re-

ports of the students and teachers that the guidance office was a poor place to regard as a resource for girls with interests in mathematics and science:

A counselor in her early 30's: "Well, if they bring me their registration card with (an AP science course) listed I'll check to see if that's really what they meant . . . but I would never encourage it. I mean, it's usually their last year and there are so many fun things going on. I think they'll be busy enough and they can get into the serious work in college."

A counselor in her 20's: "I just hate to see a girl get in over her head. I always try to place students at a level where I know they'll be successful. I mean, wouldn't it be frightful to spoil a beautiful record by doing poorly in a course your senior year."

A male director of guidance, mid-forties: "Sure, I'm for the AP Program in general, but not for encouraging girls in science necessarily. Have you looked at the Bureau of Labor Statistics? It's a contracting market. There are men with Ph.D.'s in physics all over the place who can't get jobs. Why should we encourage girls? Why, if they're successful, they'd be taking jobs away from men who need them. No, it wouldn't be fair to the girls."

Unfortunately, these comments were chosen not because they were unique but because they represented all too commonly the attitudes of the counselors in many schools. It is no wonder that a science supervisor, when asked at a meeting of AP science teachers (who happened to agree with him) whether counselors were helpful, responded, "Helpful? All I can say is that it's too bad they outlawed hanging . . . yes, it's too bad. . . ." It's really too bad that counselors have little time to get to know the students who aren't in difficulty of one sort or another. Not being aware of the depth of a superior student's interests and aspirations is one problem. The fact that most *counselors have little or no background* in mathematics and the physical sciences is another, perhaps a more serious one. At some junior high schools this lack leads to the counselors trying to dissuade girls from taking the industrial arts and shop courses they desire (as well as accelerated mathematics and science programs). A good physical science course has often given girls their first taste of building apparatus and using tools, and they are anxious to expand their competencies. Yet the attitude lingers that, while such courses are "practical and proper" for boys, "who will use those skills in their hobbies if not in their jobs," they are superfluous for girls. There was the suspicion among students at some schools that since the boys' interest in such courses was more "legitimate," they were given preference when places were limited.

Strangely, science is scary to many professional counselors; and studies and training required to achieve professional status in such fields are long and seem even longer to them. Rather than encourage girls to try AP courses and (it is hoped) save time and money in college, many counselors would rather redirect the girl into some other field, all with the best intentions that they "not work too hard," "enjoy life while they can," and certainly not court "discouragement or possible failure." This latter concern is unrealistic, as counselors will admit when questioned. The many AP teachers with whom I discussed this matter were very careful to enroll only students who seemed qualified for their classes, and if students did get in over their heads, or couldn't keep up, they were allowed to transfer to less demanding courses with no penalty. What many female counselors seem to be doing is projecting their own anxieties and the more limited options of their late adolescences on the young women of today. When male counselors are fearful that *women will take away men's jobs*, the problem for the science-oriented girl to get as far as she can in high school is doubly difficult. In schools where such counselor attitudes prevail, the recruitment efforts of teachers become of paramount importance.

The actual AP course

When girls finally reached the AP courses with which this study is concerned, they frequently found the environment far different from that in previous classes. It was sometimes a shock and then a pleasant relief, particularly for those girls who were not products of long-time homogeneous grouping. Sexual stereotyping had no place in the classroom, and the environment was one that allowed some girls a chance to become aware of the sex-related stereotypes they had unconsciously internalized.

"Well John, would you lay out this problem the way Sue did or some other way?"

"I don't know."

"What do you mean you don't know? That you have no opinion?"

"No, sir."

"If you don't have a considered opinion, you don't belong in this class. Now, who agrees with Sue? Who has another way? Leslie?" (And so on through the rest of the class.)

The preceding exchange took place in an AP physics class. In talking about it afterwards, the girls said the class had been typical and several remarked at how terror-struck they had been the first few weeks when they were forced to contribute to the discussion, "to have an opinion." Other, more aggressive girls had immediately welcomed the teaching style. "He's absolutely even-handed; and you don't have to be right, you just have to have thought about it." For both shy and not-so-shy girls, it was the first time in any science class they felt positive sanction to speak up, much less to be wrong. They were wrong less

often than they expected.

Girls in other schools often reported similar experiences that turned out to be freeing. Their teachers had told them, "Sometimes we learn more from mistakes than from right solutions," and "Don't worry how it comes out the first time, but record your procedure exactly, then we'll see . . ." or some variation. The girls with such teachers tended to have more positive self-images than did girls with teachers for whom verbal participation was optional.

When I asked girls whether they were held back in speaking up because they were afraid of seeming too bright in front of boys, the vast majority of girls in classes in which participation was optional turned the question around. "Too bright? Oh no, I keep quiet because I'd seem too dumb." Over and over girls reported they were "really at the bottom of the class" or "just holding on." Yet when I checked with teachers, I was told that *some* of these girls were at the top of their classes, and many were reported to be "among the very best." Indeed, only three of the more than 160 girls in the study were reported as being in academic difficulties.

Forced participation did cut down on much but not all of the girls' self-depreciation. The girls' perceptions of their abilities more nearly mirrored the teachers in classes in which participation was mandatory.

When I asked the girls how they felt about getting better grades than boys, no one denied that it happened, a response interesting in itself since, according to their own reports, so many of them were doing poorly in their AP courses.

For 60 percent of the girls in the study, getting better grades either didn't make any difference, or was a "delight," or "the way it should be." Often such remarks were accompanied by smiles or laughter and "Right on, sister!" or "Yea, women!" But for the other 40 percent, high grades, although sources of personal pleasure, were best played down or denied in front of one's classmates—particularly one's non-AP classmates. "The boys in the AP class don't matter. But, if you want a date. . . ." As I remarked earlier, most girls deliberately choose to date boys from outside their AP science or mathematics classes. Some even preferred to date boys from other schools or older boys "to whom we aren't any threat." It is impossible to tell how much girls' modest self-appraisal and sensitivity about high grades is a reflection of self-inflicted stereotyping and how much is the realistic appraisal of the stereotypes held by others.

The girls' plans for the future

Remembering the hesitancy of many girls to speak up in class or to have their academic accomplishments known to male peers, one might expect that a good proportion of them would choose to continue their education at first-rate women's colleges. Such a choice would certainly allow them to separate temporarily, at least, academic accomplishment from male competition and scrutiny. I was surprised to find, however, that only sightly less than 10 percent had even considered going to a single-sex college. Only three of the graduating seniors were actually doing so. They were planning to enter Mt. Holyoke and Smith but had chosen them for reasons other than their histories of turning out eminent women scientists. Indeed, the girls were unaware of such colleges' reputations in this regard.

Although a great many of the girls' career plans were wisely tentative, most of them had already made up their minds that some branch of science and mathematics was (or was not) for them. Eighty percent were planning to continue in these fields, and 20 percent had fairly firmly decided on careers in other directions.[9]

The most popular fields in science were architecture, biochemistry, engineering, forestry, marine biology, medicine, oceanography, with veterinary medicine leading the way. Each of these fields was being seriously considered by five or more girls; 11 girls hoped to become veterinarians. Of the non-science fields, only law attracted more than five girls. The fields the girls were seriously considering are listed here:

Science and Mathematics

Architecture*
Astronautics
Astrophysics
Bio-Chemistry*
Biology
Chemistry
Computer Science
Engineering*
Environmental Science
Farm Agriculture
Forestry*
Genetics
Geology
Mathematics
Marine Biology*
Medical Technology
Medicine—unspecified*
Medicine
- Neurology
- Pediatrics
- Public Health
- Nuclear
- Space

Meteorology
Nursing
Oceanography*
Psychology
Physics
Scientific Writing
Veterinary Medicine*

Other Fields

Art
English
French

* Mentioned by five or more girls.

9. A further study of young women in the Advanced Placement mathematics sequence now being conducted by the author indicates that this finding is no longer valid for young women currently enrolled in AP mathematics. As opportunities for young women open up in traditionally "male" fields, and as the mathematics component grows in heretofore "feminine" fields, young women are coming to regard the calculus as part of a broad, general education.

Other Fields (Cont.)

History
Journalism
Law*
Music
Teaching
Travel

With the girls' choices being what they were, it is not surprising that almost all the girls who were planning on careers in science or mathematics expected to find themselves still "in school" five years hence. Those considering some medical specialties and certain branches of physics could see themselves as probably still in school or just finishing up 10 years in the future. But what would they *like* to be doing at the same intervals in the future? For the most part, if expectations and hopes differed—and they did for about two-thirds of the girls—the hope was to reach the desired goal sooner. They wished to be "already in practice" or "commanding an expedition" or "heading a task force to. . . ." For the others the desire was to be taking a year off for travel, or, at the ten-year interval, to be thinking about "starting a family, if I decide to get married," or, "if I'm married at that time."

A majority of girls did not spontaneously mention marriage in their future plans. When I brought up the subject as a follow-up to "What do you expect or hope to be doing . . ?" their responses were on the cool side. No one said in response to the follow-up question, "Of course, I take that for granted." The kinds of comments they did make ranged instead from "perhaps" and "I suppose so, if the right guy has come along," to "Yes, if I can work it out with my professional life" and "Who needs to get married today?" One of the outstanding characteristics of these girls as a group was that they were not going to define their adult identities in terms of their husbands. Marriage was acceptable, often hoped for, but not at the expense of abandoning the development of one's interests, competencies, and career.

As for children, a large number of the girls oriented toward science planned to postpone motherhood until they were "established" or had, at least, completed training in their chosen fields. Only a handful were thinking of staying home full time in the early years in the lives of their offspring. But a majority were planning to cut back in professional activities and work part time for "two or three years." There was some but not much sentiment that mothers should stay home until their children reached school age. It should be pointed out that, in their plans for combining motherhood with a career, many girls were voluntarily choosing patterns that their mothers had lived because of economic necessity rather than interest and professional commitment, although there were many mothers in this latter category too. In either case, the quality of "mothering" the girls had received seemed sufficiently satisfactory that no girl felt that she needed to change the pattern for her own children. On the other hand, one girl in a large discussion group received applause from her classmates when she remarked, "Besides, there's no one who can tune her children out as completely as a mother who's always home."

It would seem worthwhile to follow-up these girls every few years through college and beyond to see how nearly their lives follow their projected courses. But in the meantime, let us consider and summarize those things that do or could go on in schools that encourage and assist high school girls to develop interests, strengths, and career ambitions in mathematics and the physical sciences.

Conclusions and recommendations

1. AP courses in mathematics, chemistry, and physics provide girls an excellent curricular stimulus and preparation toward professional careers in these and related fields. Fully 80 percent of the girls who participated in the study plan to continue in these fields. Yet many schools' AP science programs rest on a constricted set of assumptions and attitudes.

Recommendations: That schools be encouraged to offer AP courses in these fields; that girls' enrollments in them be actively sought out; and that the strategy and tactics of this program be deliberately thought through—starting in the early years of junior high school—rather than being simply allowed to grow.

2. AP teachers in mathematics, chemistry, and physics are excellent agents for recruiting girls to these fields for study and later careers.

Recommendation: That the departmental role in soliciting and accepting enrollments be visible, recognized, and strong.

3. Much effective college and career counseling takes place in AP classes. Often AP teachers are the only good source within the school of specific information about the financial, academic, and professional opportunities now open to young women in these fields.

Recommendation: That schools encourage and enable AP mathematics and science teachers to obtain appropriate materials to serve this purpose.

4. Many counselors have been poor sources of encouragement for girls interested in mathematics and the physical sciences.

Recommendations: (1) That counselors become sensitized to their personal attitudes toward mathematics and the physical sciences and toward professional women in these fields. (2) That they recognize their responsibility to keep options open for students and encourage all eligible girls (and boys) in early junior high school to accelerate in mathematics even if

* Mentioned by five or more girls.

the students' interests in mathematics or science seem vague and undefined.

5. Older girls were often credited by current AP girls as having encouraged their interest in science and mathematics and supporting their determination to continue in the field. This encouragement was particularly important during two critical periods in the girls' school years when sexual stereotyping on the part of some adults within the school led to lack of support for girls who wished to follow the most rigorous curricular path. The first period was in early junior high school, when the choice was made whether or not to take algebra in the eighth grade. The second was in late senior high school years, when the choice was made between AP and regular college preparatory courses.

Recommendations: (1) That girls from AP classes be invited to participate in science demonstrations for elementary school students and in explaining the opportunities and advantages provided by various curricular choices to junior high schools girls. (2) That former AP students, continuing their mathematical and scientific studies in college, be invited to talk not only with girls currently in AP classes but with younger girls enrolled in science courses.